parameter is as low as 0.113 in practical veenas and it indicates possible 'closeness to perfection' of the conventional veena that can be constructed. However, in a veena with $N = 22$ the concordance d remains reasonably low over a large number of overtones as partially shown in the table. This indicates the nearness to perfection that Bharatha[2,4] has achieved in the design of a veena over a millennium ago. That he could invent this value for N of 22 over its nearest contenders, viz. 24 and 17 using perhaps only his trained ears is, we consider, really very commendable.

The evolution of the cochlear reeds is such as to separate out, i.e. Fourier transform, the frequency components in the incident sonar signal harmonics[3]. This involves propagation of the pressure waves in the cochlear fluid and the vibrations of the resonating reeds whose persistence duration could be 40 ms or more which is of the same order as photochemical transitions in our eyes. Besides, it is known that the low frequency, ~ 200 Hz or less, harmonics penetrate deep into the cochlear fluid while the high frequency ones penetrate only near its base. Besides, at less than about 200 Hz, the depth of penetration of the sonar signals gets saturated at the far end of the cochlea and it appears that the sonar signals are communicated via the cerebral cortex to the perception centers by a different mechanism; details of which are not very clear as yet.

Table 1 shows that the harmonics generated by the fundamentals at each note are either fundamentals or harmonics and hence are in good harmony with other notes within the scale. In other words, when any of the 72 Janaka Ragas or their numerous derivatives forming an extended musical tune and spanning over multitudes of octaves is played, only a specific fraction of the responding resonating reeds are called upon to participate in the associated transduction; the remaining reeds remain practically stationary contributing to the overall harmony and perception of the musical performance, i.e. each Raga above is associated with a specific narrow band of reeds for its perception, while the rest of the reeds act as silent 'spectators'.

To conclude, in view of the fact that the perception in the human brain is frequency based, here we considered a similar approach for the analysis of the notes. It was found that only when the octaves are divided into a specific number of notes, viz. 12, 17, 22, 24 etc., the veena produced concordant, melodious and harmonious tunes. The reasons for this specificity are ascribed to the requirements to be fulfilled by the active lengths of the wires that (i) these lengths from the bridge to the corresponding frets shall follow a geometric relation given by eq. (1) above and that (ii) the various tunes generated by these wires shall follow faithfully the laws of vibrating strings which state that for a uniform, stretched string, the frequency of the sound generated when it is plucked is inversely related to its length.

1. Rao, P. P., *Curr. Sci.*, 2001, **81**, 633–634.
2. Bhat, K. K., *Bharathiya Sangeetha*, D. V. K. Murthy, Mysore, 1971.
3. Guyton, A. C., *Textbook of Medical Physiology*; Saunders & Co, Tokyo, VI edn, 1981.
4. Kirkpatrick, L. D., *Physics – A World View*; Saunders, 1998, III edn, chapter 15.

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Rediscovery of *Podocarpus wallichianus*: A rare gymnosperm from tropical rain forests of Great Nicobar Island

During our fieldwork in the tropical rain forests of Great Nicobar Island (Figure 1) we came across a plant in a seedling stage (about 40 cm in length), on the East-West Road, 13 km from the Campbell Bay. It was identified as *Podocarpus wallichianus* (*P. latifolia*).

In 1888, J. D. Hooker while treating the gymnosperms has mentioned three species under the tribe Podocarpae, viz. *P. cupressina* R. Br., *P. neriifolia* D. Don. and *P. latifolia* Wall. Phytogeographically *P. latifolia* is known to occur in Khasia mountains, South Deccan, Myanmar and Malay peninsula and Java. *P. neriifolia* is distributed in the tracts of tropical Himalayas and Malaya peninsula. *P. cupressina* is found to occur in the upper Myanmar[1]. So there was no record of the distribution of this plant from the Andaman and Nicobar Island until 1953 when K. C. Sahni collected the plant during a joint expedition to the island headed by B. S. Chengappa. The plant specimen was collected in the interior of the Great Nicobar Island in vegetative stage from a small tree on the hillside above Alexandra River near the Shompen Hut[2]. Since then, several expeditions were undertaken in Great Nicobar Island but this species could not be located. Hence the present report is of special significance.

The collection of the plant *P. wallichianus* (Figure 2) (family Podocarpaceae) is interesting due to its unique distribution in the Nilgiri Hills in Tamil Nadu, Assam, Martaban, Tanasserim usually at the altitude of 900–1500 m and complete absence from the rest of the Andaman and Nicobar islands. Podocarpaceae experienced drastic reduction in number and geographical extent sometime during the later part of the Cretaceous period, but continued to survive in

Figure 1. Tropical rain forests of Great Nicobar Island.

Figure 2. *Podocarpus wallichianus*.

diminished numbers all through the Tertiary period[3]. The continents now separated by vast seas were at one time connected into super-continental landmass, the Gondwanaland. It was during the Cretaceous that the continents acquired their present configuration, the Atlantic Ocean widened and the Gondwanaland was broken up. During this period conifers became dominant gymnosperms. However during the Late Cretaceous period, the angiosperms diversified and gymnosperms started declining. Pollen grains (Podocarpaceae and Auraucaceae) have also been recovered from various Jurassic–Late Cretaceous strata of India and this points towards their extensive distribution in India during this age.

On the basis of the above discussion and the phyto-geographically strategic location of the Great Nicobar Island between mainland India, Myanmar and Thailand on the one hand and Sumatra (Indonesia) and Malaya peninsula on the other, these findings may help understand the evolutionary history of the island over the geological time scale and the origin of its magnificent rain forest. Since we noticed only a single plant of *P. wallichianus*, researchers penetrating more deeply into the area in the future would do well to report on how widely they find this distinctive species, which has remained unseen for almost half of a century. A brief description of the mature tree is given below.

Large evergreen tree up to ca 24 m high, bark smooth, mottled brown and white; wood aromatic. Leaves opposite or sub-opposite, coriaceous, ovate-lanceolate, many-nerved, 7.6–17.7 cm long, 1.27–5 cm wide; petiole very short, 2 mm long. Male spikes, 2–5 together, sessile or on a short peduncle : bract ovate, acuminate, denticulate. Seeds solitary, ovoid, 1.9 cm across, blue-black, seated on a fleshy receptacle.

Podocarpus wallichianus Presl, C., *Bot. Bemerk*, 1844, **110**; Pilger in *Engler*, *Pflanzenr*., IV-5, Ht. 18: 59; Raizada & Sahni, *For*. *Rec*., 1960, **5**(2), 105; Sahni, K. C., in *Indian For.*, 1953, **79**, 75; Dallimore & Jackson (rev. Harrison), Handb. Conif. and Ginkgo., 1954, edn 3, 85; *Podocarpus latifolia* Wall Pl. As. Rar. 1.26.t. 30.1830. Hooker JD f., *Flora Br. India*, 1888, **5**, 649; Brandis, *Indian Trees*, 1906, **695**.

1. Hooker, J. D., *Flora Br. India*, 1888, **5**, 649–650.
2. Sahni, K. C., *Indian For.*, 1953, **79**, 3–16.
3. Ramanujam, C. G. K., *Indian Gymnosperms: In Time and Space* (Reprinted from *Aspects of Plant Sciences*, 1976), Today and Tomorrow's Printers and Publishers, New Delhi, 1976, p. 101

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